Marine Physical Laboratory

Autonomous Acoustic Source

William S. Hodgkiss

Supported by the
Office of Naval Research
Grant N00014-00-1-0377

Final Report

June 2002

University of California , San Diego
Scripps Institution of Oceanography

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. Agency Use Only (Leave Blank).	2. Report Date. June 2002	3. Report Type and Dates Covered. Final Report

4. Title and Subtitle.
Autonomous Acoustic Source

5. Funding Numbers.
N00014-00-1-0377

6. Author(s).
William S. Hodgkiss

Project No.
Task No.

7. Performing Monitoring Agency Names(s) and Address(es).
University of California, San Diego
Marine Physical Laboratory
Scripps Institution of Oceanography
San Diego, California 92152

8. Performing Organization Report Number.

9. Sponsoring/Monitoring Agency Name(s) and Address(es).
Office of Naval Research
Ballston Centre Tower One
800 North Quincy Street
Arlington, VA 22217-5660
Jeffrey Simmen, ONR 321OA

10. Sponsoring/Monitoring Agency Report Number.

11. Supplementary Notes.

12a. Distribution/Availability Statement.
Approved for public release; distribution is unlimited.

12b. Distribution Code.

13. Abstract (Maximum 200 words).

An autonomous acoustic source buoy system has been designed and fabricated for use in the collection of underwater acoustic propagation data. The system consists of a surface buoy which provides battery power, signal waveform synthesis, power amplification, system control, and wireless local area network (WLAN) communications.

14. Subject Terms.
acoustic source buoy, waveform synthesis, power amplification, system control

15. Number of Pages.
8

16. Price Code.

17. Security Classification of Report.	18. Security Classification of This Page.	19. Security Classification of Abstract..	20. Limitation of Abstract.
Unclassified	Unclassified	Unclassified	None

DURIP: Autonomous Acoustic Source

W.S. Hodgkiss

Marine Physical Laboratory
Scripps Institution of Oceanography
La Jolla CA 92093-0701

Abstract

An autonomous acoustic source buoy system has been designed and fabricated for use in the collection of underwater acoustic propagation data. The system consists of a surface buoy which provides battery power, signal waveform synthesis, power amplification, system control, and wireless local area network (WLAN) communications.

Hardware Summary

The hardware components for the autonomous acoustic source system were acquired under three fabrications: (1) Buoy Mechanical/Structural Assembly, (2) Waveform Generation/Amplification, Communications, and Power Distribution Electronics, and (3) Shipboard Control Computer/Communications. The following sections will describe each of these in detail.

*A. **Surface** Buoy and Battery Pack*

The surface buoy provides flotation for the large battery pack as well as a mounting platform for the system control computer, GPS antenna for time code, 460 MHz antenna for a UHF radio modem, and 2.4 GHz antenna for the wireless local area network (WLAN) providing connectivity to the ship (see Fig.1 - taken of an identical buoy fabricated for a separate project). The buoy is a polyethylene foam float with a polyurethane outer jacket. It weighs 3375 lbs of which 1750 lbs is the battery pack. The battery pack consists of a rack of 32, 12 volt, 65 AH gel-cell batteries wired in series to provide 384 volts DC for the underwater pressure case (see Fig. 2). The rack fits inside an anodized aluminum tank which is surrounded by the foam float. The power amplifiers are mounted on the underside of the lid to the tank. On top of the tank is a waterproof box containing the card cage for the waveform synthesis and system control computer. A tripod rises 21' above the buoy to provide a mounting for the GPS, 460 MHz, and 2.4 GHz antennas. Below the buoy is a 10' section of TV tower with 200 lbs of weight on the bottom for stability. Lastly, an acoustic release for the buoy mooring and RF-beacon/flasher for locating the buoy have been included.

B. Waveform Synthesis, Power Amplification, System Control, and Communications

Waveform synthesis is carried out by a compact PCI (peripheral control interconnect) chasis with a Pentium-III 600 MHz CPU running Windows NT, a National Instruments PXI-6713 D/A for generating multiple analog waveforms, and a National Instruments PXI-6052E A/D for collecting monitor hydrophone data. Data storage is provided by IDE, 30 GB, 2.5" disk drives. All waveform synthesis, D/A, and A/D functions are carried out in LabVIEW.

Power amplification is provided by a 5-channel, Instruments Inc., switching power amplifier. Thus, as many as 5 separate transducers can be controlled from the buoy at the same time.

The system control computer consists of a compact PCI chassis with a Pentium-II 450 MHz CPU running Windows NT, a National PXI-6071E A/D for collecting ancillary time series data from a variety of environmental and motion sensors on the buoy, a GPS time code interface for synchronization to GPS time (Bancom BC637 CPCI), and an interface for the wireless local area network. Data storage is provided by IDE, 30 GB, 2.5" disk drives. In addition, the control electronics package includes a 460 MHz UHF radio modem and a Persistor CF1microcontroller for secondary control. All control functions are carried out in LabVIEW.

Primary communications with the buoy are provided by a 2.4 GHz, direct sequence spread-spectrum (DSSS), wireless local area network (WLAN) (Lucent WaveLAN 802.11). The desktop of the system control computer is operated remotely through the wireless LAN on the ship. The buoy has a simple 7 dBi omnidirectional antenna mounted at the top of the tripod (~25' off the sea surface) while the ship uses directional antennas. Amplifiers on the buoy and the ship provide 1 watt of transmit power, up to 30 dB of gain on receive, and bandpass filtering at 2.4 GHz. The amplifiers are placed as close as possible to the antennas to reduce the effects of cable losses during transmit. If the wireless LAN becomes inoperative, a backup serial link through the 460 MHz UHF radio modem provides a means to power down the pressure case and to reboot the system control computer.

C. Shipboard Control Computer and Communications

Although autonomous operation of the acoustic source system is one mode of operation, real-time communications with the hardware is essential for experiments where modification of the source transmission schedule or source waveforms themselves is necessary. Thus, a wireless local area network (WLAN) between the ship and system control computer on the surface buoy has been included in the design. The shipboard computer itself consists of a 1.2 GHz CPU and associated peripherals. In addition, a duplicate of the buoy communications hardware is located on the ship. These include the 2.4 GHz wireless local area network along with directional antennas (both Yagi and parabolic dish) for primary communications and the 460 MHz UHF radio modem for backup purposes.

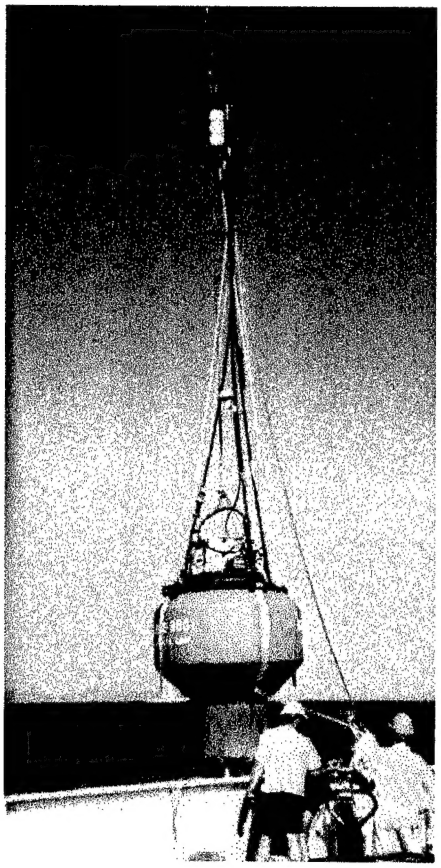

Fig. 1. The surface buoy provides battery power, waveform synthesis, power amplification, system control, and wireless local area network (WLAN) connectivity.

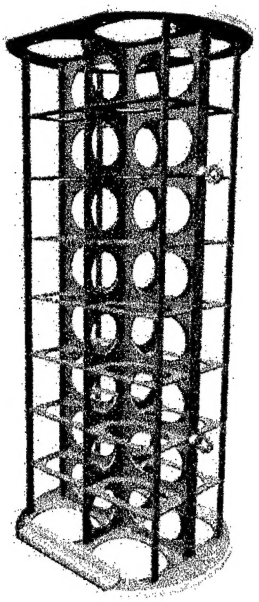

Fig. 2. The battery rack holds 32 batteries and fits inside an aluminum anodized tank surrounded by the foam float.

Fund 32972A N00014-00-1-0377 HODGKISS 13% 9/01
PI Hodgkiss, William S.

Agency OFFICE OF NAVAL RESEARCH (ONR)
Grant Number N00014-00-1-0377
Funding Amount $ 117,918.00
Grant Dates 03/01/2000-09/30/2001
Budget Dates 03/01/2000-09/30/2001
Overhead Rate M130FG MODIFIED-FEDERAL-GRANT-13.0%

Total Salaries and Benefits **11,820.83**

Total Supplies & Expenses **5,240.01**

Index	Acct	Document	Date	Description		Doc. Ref.	Expense
MPLWH44	649610	72382483	11/2/00	INSTRUMENTS, INC	000003952	10185697	26,937.50
MPLWH44	649610	72516797	7/27/01	DATUM TT&M	00BEV2928	10198736	483.00
MPLWH44	649610	72516797	7/27/01	DATUM TT&M	00BEV2928	10198736	6,440.00
MPLWH44	649610	72495926	6/19/01	SBS EMBEDDED COMPUTERS	0001(	10198737	280.35
MPLWH44	649610	72495923	6/19/01	SBS EMBEDDED COMPUTERS	0001(	10198737	3,743.60
MPLWH44	649610	72483220	5/29/01	MICROLAND ELECTRONICS	070468	10198805	186.00
MPLWH44	649610	72483220	5/29/01	MICROLAND ELECTRONICS	070468	10198805	2,480.01
MPLWH44	649610	72487186	6/5/01	NATIONAL INSTRUMENTS CORP	000(	10198806	1,930.17
MPLWH44	649610	72487186	6/5/01	NATIONAL INSTRUMENTS CORP	000(	10198806	2,123.66
MPLWH44	649610	72499189	6/23/01	MODULAR COMPUTERS, INC.	00001(	10198807	165.75
MPLWH44	649610	72499189	6/23/01	MODULAR COMPUTERS, INC.	00001(	10198807	2,210.00
MPLWH44	649610	72549343	10/8/01	METRIC EQUIPMENT	00005608(	10203708	165.00
MPLWH44	649610	72549343	10/8/01	METRIC EQUIPMENT	00005608(	10203708	2,200.00
MPLWH44	649610	72435295	2/22/01	VICOR CORPORATION	0005609(	2A792109	1,853.30
MPLWH44	649610	72443410	3/8/01	Rose Industries, Inc.	000060092	2A792113	20.78
MPLWH44	649610	72443410	3/8/01	Rose Industries, Inc.	000060092	2A792113	277.03
MPLWH44	649610	72476330	5/15/01	ONE STOP SYSTEMS	00000366	2A792118	1,273.88
MPLWH44	649610	72484735	5/31/01	ONE STOP SYSTEMS	00000373	2A792122	768.63
MPLWH44	649610	72487502	6/5/01	HYPERLINK TECHNOLOGIES	000205	2A792123	164.48
MPLWH44	649610	72487502	6/5/01	HYPERLINK TECHNOLOGIES	000205	2A792123	2,193.00
MPLWH44	649610	72518469	7/31/01	PC CONNECTION SALES CORPO	0316	2A792124	33.29
MPLWH44	649610	72518469	7/31/01	PC CONNECTION SALES CORPO	0316	2A792124	443.85
MPLWH44	649610	72481860	5/24/01	TELEDESIGN SYSTEMS, INC.	000003	2A792125	1,453.83
MPLWH44	649610	72509095	6/30/01	VICOR CORPORATION	0005822	2A844933	726.70
MPLWH44	649610	72510025	7/13/01	VICOR CORPORATION	0005822	2A844933	10.95
MPLWH44	649610	72510025	7/13/01	VICOR CORPORATION	0005822	2A844933	149.85
MPLWH44	649610	72436410	2/26/01	Sorensen,	00S261595	2A845922	1,531.88
MPLWH44	649610	72438719	2/28/01	Sorensen,	00S261776	2A845925	1,531.88
MPLWH44	649610	72487032	6/5/01	PERSISTOR INSTRUMENTS INC	00000	2A848901	86.25
MPLWH44	649610	72487032	6/5/01	PERSISTOR INSTRUMENTS INC	00000	2A848901	1,150.00
MPLWH44	649610	72537150	9/10/01	DATUM TT&M	00BEV3518	2A848911	75.00
MPLWH44	649610	72537150	9/10/01	DATUM TT&M	00BEV3518	2A848911	1,000.00
MPLWH44	649610	72544318	9/27/01	INSTRUMENTS, INC	000004072	2A848916	537.50
MPLWH44	649610	72547226	10/3/01	TECHNI-TOOL	000446834	2A848917	192.53
MPLWH44	649610	72439507	3/1/01	Sorensen,	00S261815	2A892076	1,531.88
MPLWH44	649610	72443293	3/8/01	Sorensen,	00S262074	2A892083	1,531.88

Total Fabrication of Autonomous Acoustic Source Waveform Generation/Amplification Communications, & Power Distribution Electronics **67,883.41**

MPLWH44	649610	72382972	11/3/00	Gilman Corporation	000010429	10190346	391.14

MPLWH44	649610	72382972	11/3/00	Gilman Corporation	000010429	10190346		5,047.00
MPLWH44	649610	72429797	2/12/01	Novatech Designs Limited	00001103	10194435		58.05
MPLWH44	649610	72429797	2/12/01	Novatech Designs Limited	00001103	10194435		774.00
MPLWH44	649610	72468674	4/27/01	EdgeTech	000123817	10194469		337.50
MPLWH44	649610	72468674	4/27/01	EdgeTech	000123817	10194469		4,500.00
MPLWH44	649610	72468212	4/27/01	POWERSTRIDE BATTERY	00U416	10195303		4,160.68
MPLWH44	649610	FRMPLD39	6/30/01	MPL SHOP LABOR RECHARGE		01A66.12		897.00
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET EARLE M JORGENSEN CO	6	2A824062		113.78
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET EARLE M JORGENSEN CO	6	2A824062		1,468.12
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET ALL METALS PROCESSING OF		2A845858		116.25
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET ALL METALS PROCESSING OF		2A845858		1,500.00
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET EARLE M JORGENSEN CO	1	2A853409		171.41
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET EARLE M JORGENSEN CO	1	2A853409		13.28
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET EARLE M JORGENSEN CO	6	2A853409		50.17
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET EARLE M JORGENSEN CO	6	2A853409		647.40
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET ADVANCED METAL FORMING, I		2A853411		527.98
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET ADVANCED METAL FORMING, I		2A853411		(37.98)
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET COAST ALUMINUM	000	2A853412		18.34
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET COAST ALUMINUM	000	2A853412		236.60
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET TALLEY COMMUNICATIONS CO		2A853416		244.76
MPLWH44	649610	72582195	12/13/01	PACIFIC RIGGING LOFT, INC	00005467	2A870722		70.95
MPLWH44	649610	72502997	6/28/01	MCMASTER-CARR SUPPLY COMP	043	2A882134		234.93
MPLWH44	649610	NIMPLAAZ	8/30/01	ENPET MCMASTER-CARR SUPPLY CON		2A882134		(155.49)
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET A & R INDUSTRIAL SUPPLY	0(	2R853456		186.19
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET HIXSON METAL FINISHING	00	2R853582		7.75
MPLWH46	649610	NEMPLAAC	8/30/01	ENPET HIXSON METAL FINISHING	00	2R853582		100.00
MPLWH44	649610	FRMPLD29	10/31/00	MPL SHOP LABOR RECHARGE		FAB 530		92.00
MPLWH44	649610	FRMPLE34	2/28/01	MPL SHOP MATERIAL RECHARGE		FAB 530		110.60
MPLWH44	649610	FRMPLE35	3/31/01	MPL SHOP MATERIAL RECHARGE		FAB 530		152.01
MPLWH44	649610	FRMPLE36	4/30/01	MPL SHOP MATERIAL RECHARGE - STO		FAB 530		(152.01)
MPLWH44	649610	FRMPLE36	4/30/01	MPL SHOP MATERIAL RECHARGE - STO		FAB 530		157.08
MPLWH44	649610	FRMPLD38	5/31/01	MPL SHOP LABOR RECHARGE - MAY 0		FAB 530		184.00
MPLWH44	649610	FRMPLE37	5/31/01	MPL SHOP MATERIAL RECHARGE - MA		FAB 530		1,510.35
MPLWH44	649610	FRMPLE39	6/30/01	MPL SHOP MATERIAL RECHARGE		FAB 530		170.26
MPLWH44	649610	FRMPLD42	8/31/01	MPL SHOP LABOR RECHARGE ADJUSTI		FAB 530		(345.00)
MPLWH44	649610	FRMPLD42	8/31/01	MPL SHOP LABOR RECHARGE ADJUSTI		FAB 530		1,069.50
MPLWH44	649610	FRMPLE42	8/31/01	MPL SHOP SUPPLY RCHG		FAB 530		97.89
MPLWH44	649610	FRMPLE42	8/31/01	MPL SHOP SUPPLY RCHG		FAB 530		268.75
MPLWH46	649610	FRMPLD42	8/31/01	MPL SHOP LABOR RECHARGE		FAB 530		1,564.00
MPLWH46	649610	FRMPLD42	8/31/01	MPL SHOP LABOR RECHARGE - ALFAN		FAB 530		2,120.75
MPLWH46	649610	FRMPLD42	8/31/01	MPL SHOP LABOR RECHARGE ADJUSTI		FAB 530		10,718.00
MPLWH44	649610	FRMPLD43	9/30/01	MPL SHOP LABOR RECHARGE		FAB 530		115.00
MPLWH44	649610	FRMPLD43	9/30/01	MPL SHOP LABOR RECHARGE		FAB 530		7,107.00
MPLWH44	649610	FRMPLD43	9/30/01	MPL SHOP LABOR RECHARGE - ALFAN		FAB 530		133.88
MPLWH44	649610	FRMPLE43	9/30/01	MPL SHOP MATERIAL RECHARGE		FAB 530		(80.81)
MPLWH44	649610	FRMPLE43	9/30/01	MPL SHOP MATERIAL RECHARGE		FAB 530		(59.12)
MPLWH44	649610	FRMPLE43	9/30/01	MPL SHOP MATERIAL RECHARGE		FAB 530		(26.38)
MPLWH44	649610	FRMPLE43	9/30/01	MPL SHOP MATERIAL RECHARGE		FAB 530		(12.38)
MPLWH44	649610	FRMPLE43	9/30/01	MPL SHOP MATERIAL RECHARGE		FAB 530		12.69
MPLWH44	649610	FRMPLE43	9/30/01	MPL SHOP MATERIAL RECHARGE		FAB 530		27.25
MPLWH44	649610	FRMPLE43	9/30/01	MPL SHOP MATERIAL RECHARGE		FAB 530		56.43
MPLWH44	649610	FRMPLE43	9/30/01	MPL SHOP MATERIAL RECHARGE		FAB 530		75.00
MPLWH44	649610	FRMPLE43	9/30/01	MPL SHOP MATERIAL RECHARGE		FAB 530		80.81
MPLWH44	649610	FRMPLE43	9/30/01	MPL SHOP MATERIAL RECHARGE		FAB 530		211.46
MPLWH46	649610	FRMPLD43	9/30/01	MPL SHOP LABOR RECHARGE		FAB 530		92.00
MPLWH44	649610	FRMPLE44	10/31/01	MPL SHOP MATERIAL RECHARGE - ADJ		FAB 530		10.70
MPLWH44	649610	FRMPLE52	3/31/02	MPL SHOP MATERIAL RECHARGE - ADJ		FAB 530		(14.75)

Total Fabrication of Autonomous Acoustic Source Buoy Mechanical/Structural Assembly							**47,126.77**
MPLWH44	649610	72486868	6/5/01	ONE STOP SYSTEMS	00000374	10198738	3,096.09
MPLWH44	649610	72483220	5/29/01	MICROLAND ELECTRONICS	070468	10198805	-98.00
MPLWH44	649610	72483220	5/29/01	MICROLAND ELECTRONICS	070468	10198805	1,239.99
MPLWH44	649610	72487186	6/5/01	NATIONAL INSTRUMENTS CORP	000E	10198806	1,930.16
MPLWH44	649610	72499189	6/23/01	MODULAR COMPUTERS, INC.	00001(	10198807	165.75
MPLWH44	649610	72499189	6/23/01	MODULAR COMPUTERS, INC.	00001(	10198807	2,210.00
MPLWH44	649610	72488257	6/6/01	JENSEN TOOLS, INC.	279432700	2A792120	322.50
MPLWH44	649610	72500942	6/26/01	VICOR CORPORATION	0005801E	2A792121	30.75
MPLWH44	649610	72500942	6/26/01	VICOR CORPORATION	0005801E	2A792121	410.00
MPLWH44	649610	72482159	5/24/01	PC CONNECTION SALES CORPO	0314	2A844936	26.24
MPLWH44	649610	72482159	5/24/01	PC CONNECTION SALES CORPO	0314	2A844936	349.85
MPLWH44	649610	72481736	5/23/01	BEACON WORLDWIDE LLC	91000	2A844937	11.85
MPLWH44	649610	72481736	5/23/01	BEACON WORLDWIDE LLC	91000	2A844937	168.76
MPLWH44	649610	72523132	8/9/01	NEWARK ELECTRONICS	00391312	A844938	24.82
MPLWH44	649610	72523134	8/9/01	NEWARK ELECTRONICS	00391412	A844938	17.00
MPLWH44	649610	72518468	7/31/01	PC CONNECTION SALES CORPO	0316	2A844941	59.62
MPLWH44	649610	72518468	7/31/01	PC CONNECTION SALES CORPO	0316	2A844941	794.95
MPLWH44	649610	72486375	6/4/01	BEACON WORLDWIDE LLC	91000	2A844942	215.00
MPLWH44	649610	72494374	6/18/01	DATEL SYSTEMS	00SI77438	2A848907	1,499.63
MPLWH44	649610	72488951	6/7/01	PC CONNECTION INC	03150647	2A848908	9.36
MPLWH44	649610	72488951	6/7/01	PC CONNECTION INC	03150647	2A848908	124.75
MPLWH44	649610	72434471	2/21/01	JENSEN TOOLS, INC.	275273400	2A892077	611.68
MPLWH44	649610	72438996	3/1/01	JENSEN TOOLS, INC.	275523500	2A892082	29.93
MPLWH44	649610	72438996	3/1/01	JENSEN TOOLS, INC.	275523500	2A892082	399.00
Total Fabrication of Autonomous Acoustic Source Shipboard Control Computer/ Communications							**13,840.68**
TOTAL EQUIPMENT COSTS							**128,850.86**
TOTAL DIRECT COSTS							**145,911.70**
INDIRECT COSTS 13% OF MTDC							**2,217.91**
TOTAL PROJECT COSTS							**148,129.61**
N00014-00-1-0376 AWARD							**117,918.00**
CONTRIBUTION BY UNIVERSITY							**30,211.61**

ONR/MPL REPORT DISTRIBUTION

Office of Naval Research (3)
Department of the Navy
Ballston Tower One
800 North Quincy Street
Arlington, VA 22217-5660
Atten: Jeffrey Simmen, ONR 321OA

Regional Director (1)
ONR Detachment
San Diego Regional Office
4520 Executive Drive, Suite 300
San Diego, CA 92121-3019

Commanding Officer (1)
Naval Research Laboratory
4555 Overlook Avenue, S.W.
Attn: Code 2627
Washington, D.C. 20375-5320

Defense Technical Information Center (4)
8725 John J. Kingman Road
Suite 0944
Ft. Belvoir, VA 22060-6218